

An Integrated 0-1 hour First-Flash Lightning Nowcasting, Lightning Amount and Lightning Jump Warning Capability

John Mecikalski

Chris Jewett

Larry Carey

Brad Zavodsky

Geoffrey Stano

Lightning one of the most dangerous weather-related phenomena, especially as many jobs and activities occur outdoors, presenting risk from a lightning strike. Cloud-to-ground (CG) lightning represents a considerable safety threat to people at airfields, marinas, and outdoor facilities—from airfield personnel, to people attending outdoor stadium events, on beaches and golf courses, to mariners, as well as emergency personnel. Holle et al. (2005) show that 90% of lightning deaths occurred outdoors, while 10% occurred indoors despite the perception of safety when inside buildings. Curran et al. (2000) found that nearly half of fatalities due to weather were related to convective weather in the 1992-1994 timeframe, with lightning causing a large component of the fatalities, in addition to tornadoes and flash flooding. Related to the aviation industry, CG lightning represents a considerable hazard to baggage-handlers, aircraft refuelers, food caterers, and emergency personnel, who all become exposed to the risk of being struck within short time periods while convective storm clouds develop. Airport safety protocols require that ramp operations be modified or discontinued when lightning is in the vicinity (typically 16 km), which becomes very costly and disruptive to flight operations. Therefore, much focus has been paid to nowcasting the first-time initiation and extent of lightning, both of CG and of any lightning (e.g, in-cloud, cloud-to-cloud).

For this project three lightning nowcasting methodologies will be combined: (1) a GOES-based 0-1 hour lightning initiation (LI) product (Harris et al. 2010; Iskenderian et al. 2012), (2) a High Resolution Rapid Refresh (HRRR) lightning probability and forecasted lightning flash density product, such that a quantitative amount of lightning (QL) can be assigned to a location of expected LI, and (3) an algorithm that relates Pseudo-GLM data (Stano et al. 2012, 2014) to the so-called “lightning jump” (LJ) methodology (Shultz et al. 2011) to monitor lightning trends and to anticipate/forecast severe weather (hail ≥ 2.5 cm, winds ≥ 25 ms⁻¹, tornadoes). The result will be a time-continuous algorithm that uses GOES satellite, radar fields, and HRRR model fields to nowcast first-flash LI and QL, and subsequently monitors lightning trends on a per-storm basis within the LJ algorithm for possible severe weather occurrence out to ≥ 3 hours. The LI-QL-LJ product will also help prepare the operational forecast community for Geostationary Lightning Mapper (GLM) data expected in late 2015, as these data are monitored for ongoing convective storms.

The LI-QL-LJ product will first predict where new lightning is highly probable using GOES imagery of developing cumulus clouds, followed by an analysis of NWS (dual-polarization) radar indicators (reflectivity at the -10 °C altitude) of lightning occurrence, to increase confidence that LI is immanent. Once lightning is observed, time-continuous lightning mapping array and Pseudo-GLM observations will be analyzed to assess trends and the severe weather threat as identified by trends in lightning (i.e. LJs). Additionally, 5- and 15-min GOES imagery will then be evaluated on a per-storm basis for overshooting and other cloud-top features known to be associated with severe storms. For the processing framework, the GOES-R 0–1 hour convective

initiation algorithm's output will be developed within the Warning Decision Support System – Integrated Information (WDSS-II) tracking tool, and merged with radar and lightning (LMA/Pseudo-GLM) datasets for active storms. The initial focus of system development will be over North Alabama for select lightning-active days in summer 2014, yet will be formed in an expandable manner. The lightning alert tool will also be developed in concert with National Weather Service (NWS) forecasters to meet their needs for real-time, accurate first-flash LI and timing, as well as anticipated lightning trends, amounts, continuation and cessation, so to provide key situational awareness and decision support information. The NASA Short-term Prediction Research and Transition (SPoRT) Center will provide important logistical and collaborative support and training, involving interactions with the NWS and broader user community.